Distributed Resources

Thoughts on a Discussion Framework

Planning Meeting
Saint Paul, Minnesota
October 9, 2013

Matt Schuerger
Energy Systems Consulting Services, LLC

Outline of Presentation

- Distributed Resources
  - Overview, Characteristics, Values, Challenges
- Distribution System
  - Context, Impacts
- Future (Tomorrow) Grid
  - A Work in Progress
- Integration
  - Lessons from Wind Integration (Regional Grid)
  - Distributed Resource Integration (Local Distribution)
- Discussion

Biography, Resources

Overview

Distributed Resources are supply and demand side resources that can be used throughout an electric distribution system to meet energy and reliability needs of customers; can be installed on either the customer or the utility side of the electric meter;

- Include ***Efficiency*** (End use efficiency), ***Distributed Generation*** (Solar PV, Combined heat and power, Small wind), ***Distributed Flexibility and Storage*** (Demand response, Electric vehicles, Thermal storage, Battery storage), and ***Distributed intelligence*** (Information and control technologies that support system integration)

- May have unique site, operations, and ownership characteristics

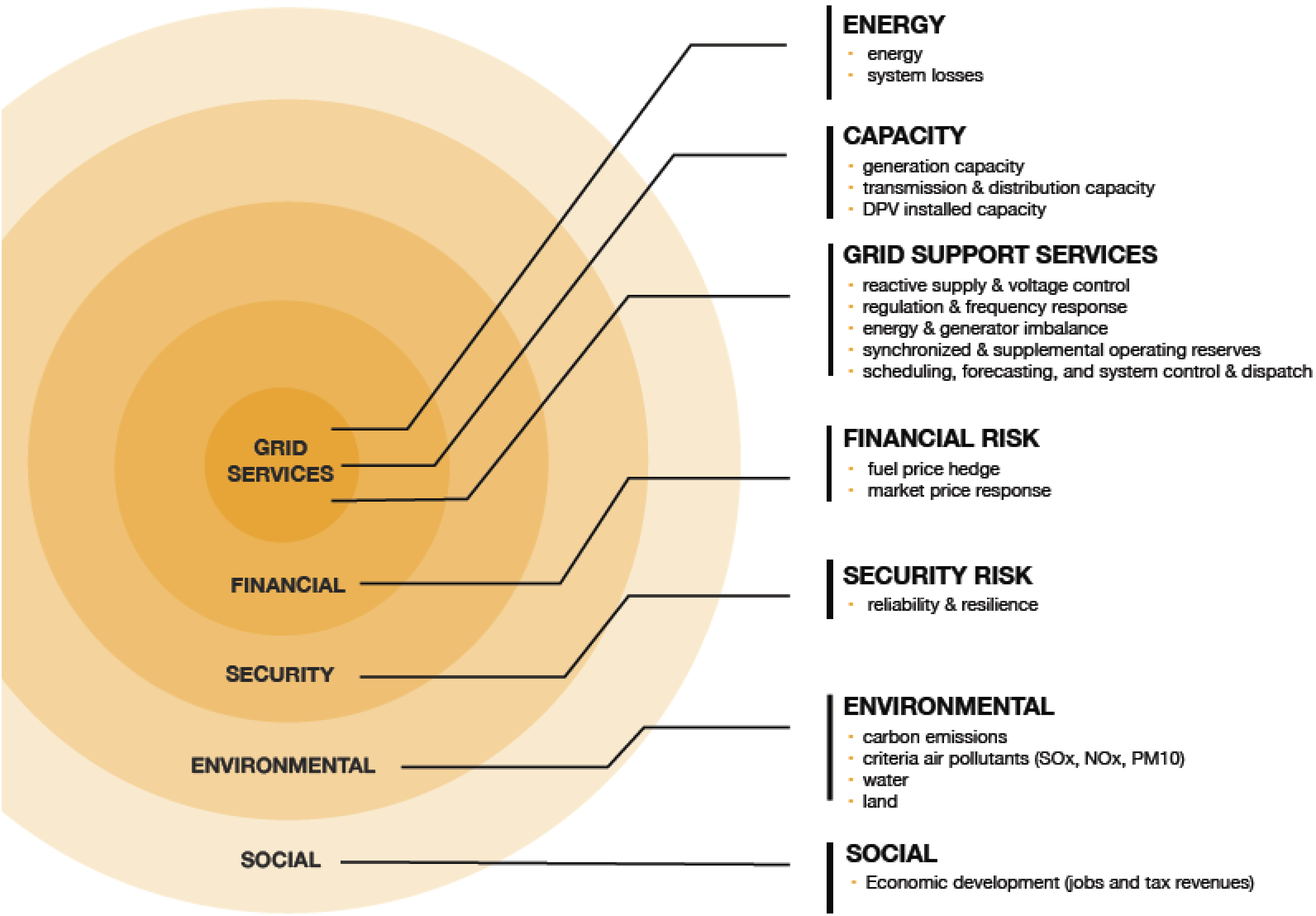
Values & Challenges

- An integrated system of Distributed Resources can provide:
  - **New, and not yet recognized, values**

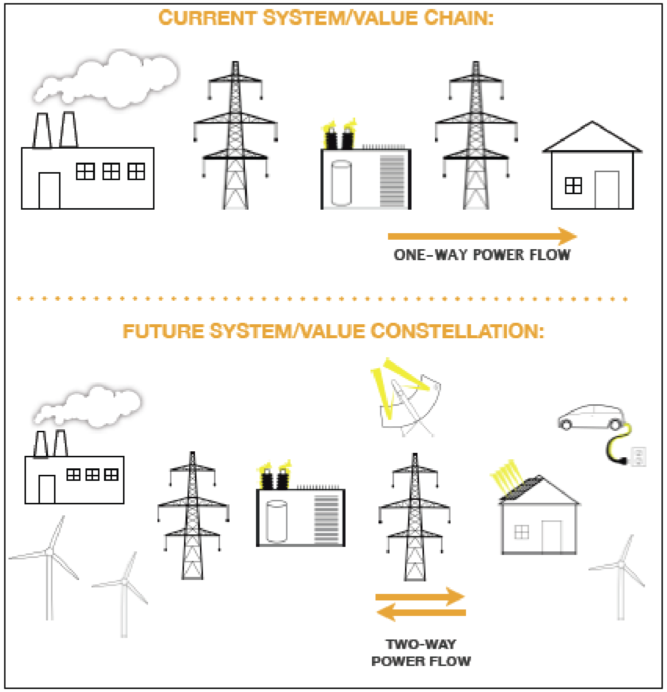
as well as:

  - **New, and not yet resolved, challenges** to distribution systems, operations, pricing, and regulatory mechanisms designed for conventional resources

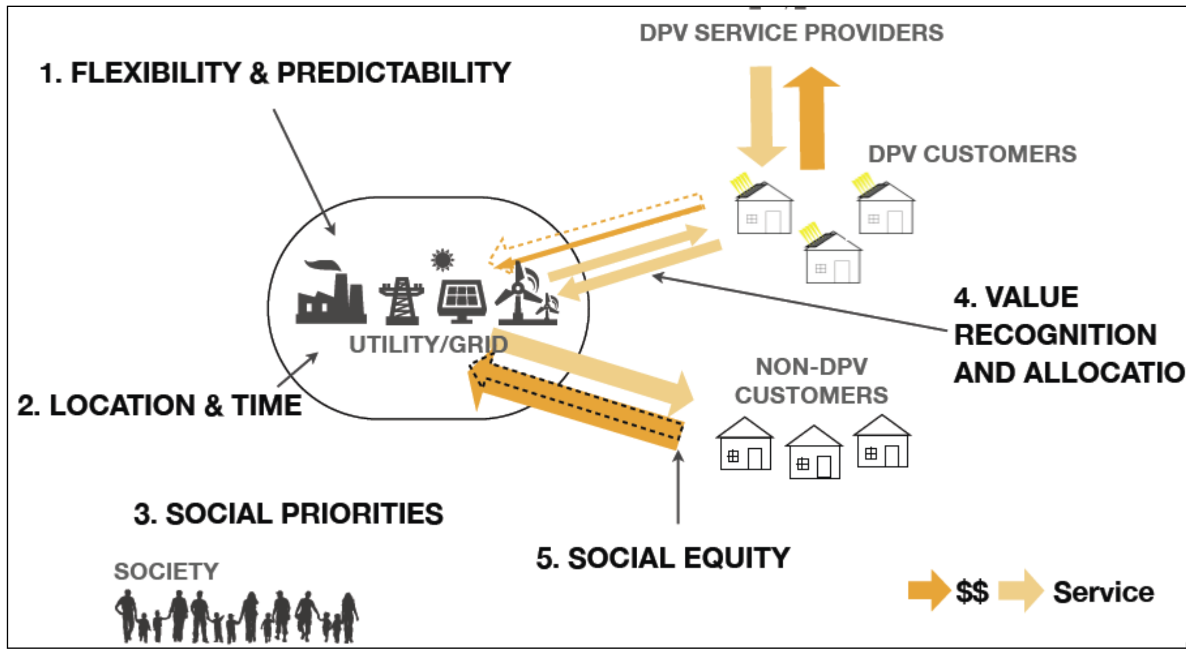
A VARIETY OF CATEGORIES OF SOLAR BENEFITS OR COSTS ARE RECOGNIZED (NOT ALWAYS QUANTIFIED) IN REVIEWED ANALYSES



Source: RMI Presentation at MN Commerce VOST Stakeholder Workshop 1. September 17, 2013.

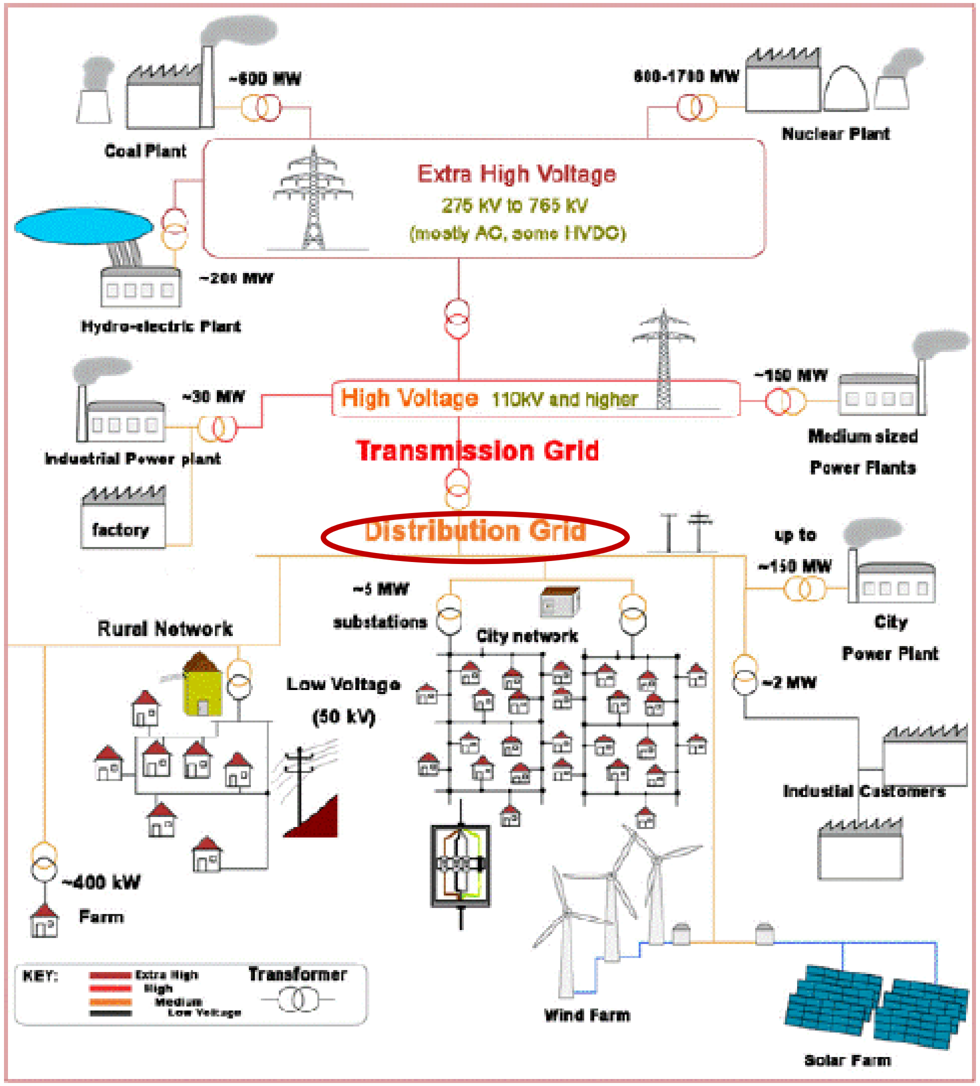


Structural Misalignments



Source: RMI Presentation at MN Commerce VOST Stakeholder Workshop 1. September 17, 2013.

Technical Context – Codes & Standards



Bulk System Guidelines
NERC, FERC
IEEE, ANSI, IEC
NESC

Technical and jurisdictional overlap

Distribution System Guidelines
IEEE 1547, PUC/PRC
IEEE, ANSI, IEC
NEC

Source: NREL Presentation at MN Commerce DG Interconnection Meeting. May 31, 2012.

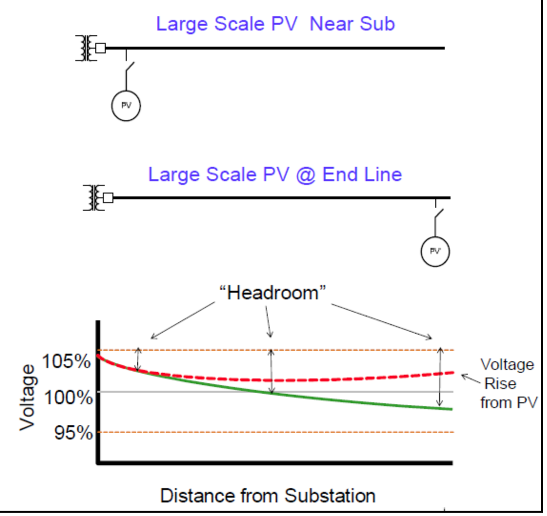
Impacts on Distribution Systems: Distributed PV Feeder Analysis

Evaluation Criteria include:

- Voltage
- Protection system
- Power quality
- Loading
- Operations

Key Factors that Determine How Much PV a Feeder Can Accommodate (Hosting Capacity)

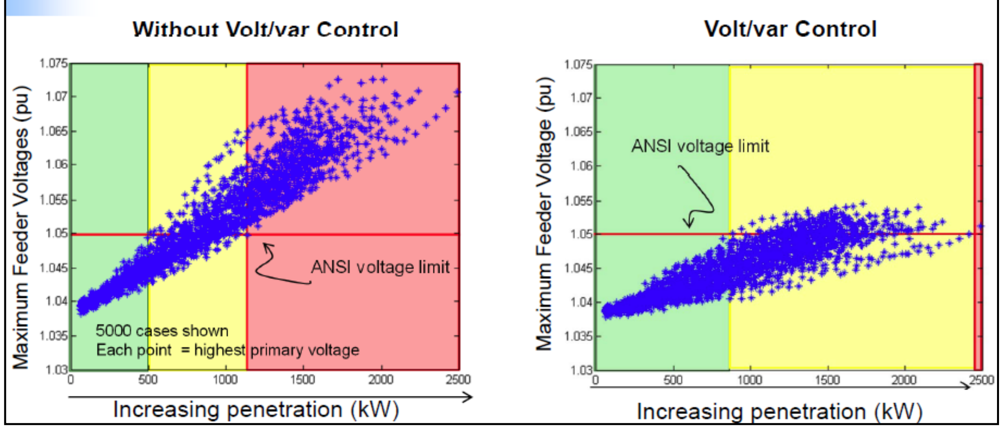
- Size of PV
- **Location** of PV
- Feeder characteristics
- Electrical proximity to other PV
- Unique solar resource characteristics in the area
- PV control



Solutions include:

Increasing Hosting Capacity with Smart Inverters

Overvoltage Results for Feeder J1



Source: EPRI, Daniel Brooks & Jeff Smith. Presentations IEEE PES July 13, Lisbon Nov 12.

Evolution of the Grid

- <u>Grid I</u>
  - In the late 1800s, early builders of small local grids, both Edison (DC) and Westinghouse (AC), demonstrated that reliable power systems require controls instantly balance generation against demand
- <u>Grid II</u>
  - By the second half of the last century, power systems had developed to become larger, more complex, and more difficult to control; by the 1960s there were several large, interconnected, synchronized U.S. systems

<u>Drivers for further grid modernization include:</u>

⇨ Aging power plants, tougher environmental regulations, increasing renewable generation, changing consumer demands, *declining sales*

⇨ New distributed technologies including generation, demand response, electric vehicles, smart grid developments, communications developments

⇨ Decarbonization

- <u>Grid III</u>
  - In the next two decades, the grid will evolve to meet the increasing demands (see drivers, box above).

Sources: EPRI, Energy Foundation Midwest Briefing, others.

Future (Tomorrow) Grid

Tomorrow’s grid will:

- Be more distributed, flexible, intelligent, real-time controlled, autonomous, open *and* secure;
- Be cleaner and reliable;
- Operate resiliently against attack and natural disaster.

Tomorrow’s distribution system will:

- Enable a high level of integrated Distributed Resources, both supply and demand side, with active participation by consumers;
- Manage two way flows of electricity;
- Provide for seamless integration and interoperability of varied systems and components;
- Implement modern distribution management systems (DMS) including advanced control and communications.

Wind Integration into the Regional Grid

- 1990s:Transmission system was opened up w federal policies
- 2000s:Work on grid integration of large amounts of wind generation in Minnesota and the upper Midwest began:
  - Started to be enough wind on the system to see impacts;
  - Initial integration work focused on plugging existing wind plants (performance, technology) into the existing grid (rules/standards, topology, operational practices);
  - Several integration studies facilitated significant learning on all sides of the challenge; Required a forward looking systems approach;
  - Included advances in power electronics, controls, communications.
- Today: MISO and MN utilities are successfully integrating large amounts of wind generation into the regional grid:
  - Wind generators are able to and are required to perform much better (Low Voltage Ride Through, reactive power, dispatched);
  - The regional grid is operated and planned differently (wind forecasting in unit commitment, dispatch, regional MVP lines); new approaches/tools;
  - Reliability is high, impacts are low, costs are low.

- Next decade: Wind amounts are rising; More Work to be Done.

Integration into the Local Distribution Systems

Distributed Resource penetrations in MN are still very low; increases coming.

- *Distribution systems* are largely ‘black boxes’ – transparency is needed;
- *Distribution system planning* occurs largely in isolation from planning for other parts of the grid – coordination is needed with other planning work;
- *Distribution system planning* is based largely on historical peak loads – additional drivers should be incorporated;
- *Distribution design* is based largely on historical load characteristics – additional drivers should be incorporated;
- *Distributed generation technologies* include advances in power electronics, controls, communications – capabilities not yet tapped;
- *Distributed generation* is capable of providing active grid support but has not historically been allowed or required to do so – both will change;
- *Distributed generation* is often not visible to the system operators – challenging at high penetrations;
- *Distribution management systems* have advanced significantly including sophisticated real time functions – capabilities not yet tapped.

Thank you!

- Discussion and Questions

Biography

Matt Schuerger is an independent consultant working on power systems planning and analysis. He has over twenty five years of experience in the utility industry, including senior positions in engineering, power plant operations, and business development. He has worked extensively with the integration of large amounts of variable renewable energy into power systems including power system reliability, transmission planning, operations, market rules, and distributed generation. Matt is currently a consultant to the Minnesota Department of Commerce Division of Energy Resources (power systems reliability and planning including renewables grid integration, distributed resources, and combined heat and power).

Renewable energy integration projects include work as a consultant for: the Minnesota Department of Commerce on the 2004 Xcel Wind Integration Study, for the Minnesota Public Utilities Commission on the 2006 Minnesota Wind Integration Study, for the Minnesota Department of Commerce on the 2008 and 2009 Minnesota Dispersed Renewable Generation Studies and Minnesota Renewable Energy Standard Transmission Studies, and for DOE's National Renewable Energy Laboratory on the 2012 Hawaii Solar Integration Study, the 2011 Maui Smart Grid Demonstration Project, the 2010 Oahu Wind Integration and Transmission Study, the 2010 SPP Wind Integration Study, the 2009 Nebraska Wind Integration Study, and on the 2009 Eastern interconnection Wind Integration and Transmission Study.

Matt is a regular guest lecturer on renewables integration and reliability at the University of Minnesota Electrical Engineering Department and has also taught technical courses on renewable energy and power systems to engineers and managers on-site at Minnesota Utilities (for the University of Minnesota Center for Electric Energy) and to MISO power system operators.

Matt is a licensed Professional Engineer with a M.S. degree in Electrical Engineering (Power Systems) from the University of Minnesota, a B.S. in Mechanical Engineering from Purdue University, and an MBA from the University of St. Thomas. He is formerly the Executive Vice President of District Energy Saint Paul, Inc, a privately held provider of district heating, district cooling, and cogenerated electricity.

Matt Schuerger
Energy Systems Consulting Services, LLC
mattschuerger@esysconsult.com

Some Additional Resources

Energy Foundation and Energy Innovation. *America's Power Plan: Changing the Power System and Utility Businesses at Their Core.* 2013. http://americaspowerplan.com/

EPRI. *Needed: A Grid Operating System to Facilitate Grid Transformation.* July 2011.

EPRI. *US Experience Determining Feeder Hosting Capacity for Solar PV, Feeder Characteristics and Screening.* July 2013

Fox-Penner, Peter. *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities.* Island Press. 2010

MIT. *The Future of the Electric Grid, An Interdisciplinary Study.* December 2011. http://mitei.mit.edu/publications/reports-studies/future-electric-grid

MN Commerce DER. *Interconnection of Minnesota Distributed Generation Meeting.* May 31, 2012. (mtg notes & presentations) http://mn.gov/commerce/energy/topics/clean-energy/distributed-generation/

MN Commerce DER. *DG Workshop – Costs, Values, and Benefits*. October 11, 2012. (meeting presentations) http://mn.gov/commerce/energy/topics/clean-energy/distributed-generation/

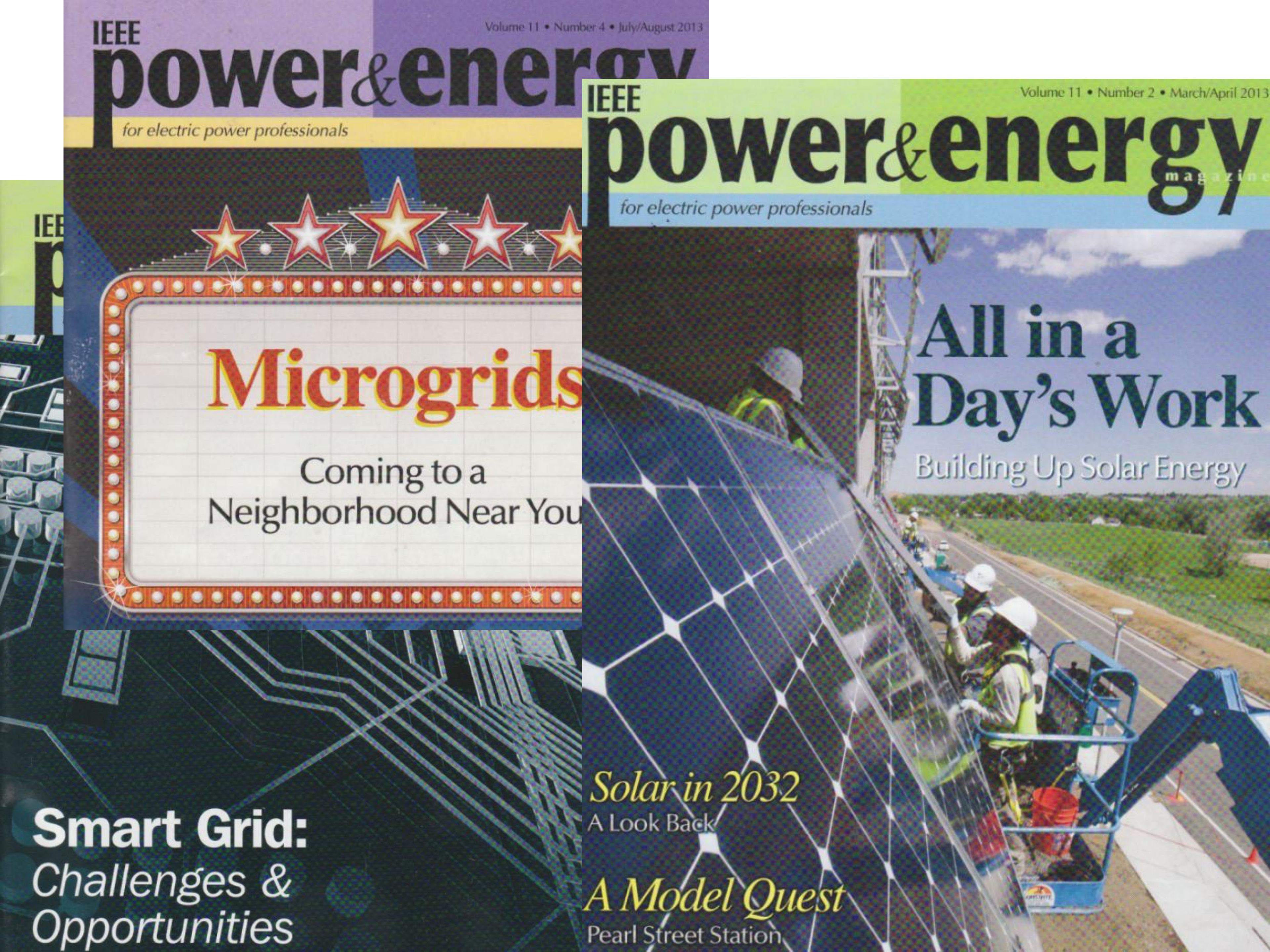
MN Commerce DER. *Value of Solar Tariff Methodology.* Fall 2013. (workshops presentations) http://mn.gov/commerce/energy/topics/resources/energy-legislation-initiatives/value-of-solar-tariff-methodology%20.jsp

NREL: Renewable Electricity Futures Study. http://www.nrel.gov/analysis/re_futures/

RMI. *A Review of Solar PV Benefits & Cost Studies*. September 2013. http://www.rmi.org/elab_empower

RMI. *Net Energy Metering, Zero Net Energy, and the Distributed Energy Resource Future, Adapting Electric Utility Business Models for the 21st Century.* February 2012.

Utility Variable Generation Integration Group (UVIG), Distributed Solar / Wind, Operating Impacts and Integration Studies User Groups. www.variablegen.org


IEEE
Volume 11 • Number 4 • July/August 2013
power&energy
for electric power professionals
Microgrids
Coming to a
Neighborhood Near You
IEEE
Volume 11 • Number 2 • March/April 2013
power&energy
magazine
for electric power professionals
All in a
Day's Work
Building Up Solar Energy
Solar in 2032
A Look Back
A Model Quest
Pearl Street Station
Smart Grid:
Challenges &
Opportunities